Fall 2011

# Nebraska Blueprint – Fall/Winter 2011

NEBRASKA

# BLUEPRINT

FALL/WINTER 2011

UNIVERSITY OF NEBRASKA–LINCOLN COLLEGE OF ENGINEERING

SINCE 1902

# HUSKER RACING


## ENGINEERING OFF-ROAD SUCCESS

# THE STAFF

Michael McEniry
Senior, MECH
Editor-in-Chief

Ben Stangl
Senior, MECH
Senior Reporter

Rajkrishna Paul
Junior, MECH
Reporter

Aditya Palnitkar
Junior, MECH
Reporter

Alif Sophian
Junior, MECH
Reporter

Matthew Nienaber
Graduate Student, ENGM
Reporter


Kathirgugan Kathirasen
Junior, MECH
Reporter

Amanda Kelebit
Junior, MECH
Photographer

Shaoshuai Gong
Sophomore, CIVE
Photographer

J.S. Engebretson
Adviser

University of Nebraska Lincoln

The Nebraska Blueprint is produced by students of the University of Nebraska–Lincoln College of Engineering and is published twice a year. Reprints in the form of articles, photography or original artwork should be addressed to Nebraska Blueprint, 203 Othmer Hall, P.O. Box 880642, Lincoln, NE 68588-0642; telephone (402) 472-6229; fax (402) 472-7792.

# FEATURES



# FROMTHEEDITOR

Dear Readers:

Welcome to the Fall/Winter 2011 issue of the Nebraska Blueprint. Since 1902, the Nebraska Blueprint has documented the students, faculty and events that have shaped the University of Nebraska–Lincoln College of Engineering. Like any organization with over 100 years of history, the Nebraska Blueprint has transitioned through prosperous times and more difficult times. The staff of the Nebraska Blueprint has gyrated from as few as four to as many as 20 in the early 1980s. The Nebraska Blueprint recently grew with the much-needed addition of seven new staff members, the largest in nearly 15 years.

Just as the Nebraska Blueprint has changed, so has the UNL College of Engineering, which now has a new dean. Dr. Timothy Wei officially became dean of the college in July 2011. To read Dean Wei's vision for the future of the College of Engineering, turn to Matt Nienaber's article.

In this issue, we also spotlight the recent successes of UNL's SAE Baja Team, Husker Racing. Reporter Kugan Kathirasen interviewed members of Husker Racing and shares the trials and triumphs of racing against other universities.

Also in this issue:

- A strong element of the College of Engineering is research. The Midwest Roadside Safety Facility is known across the United States for its innovative development of highway safety barriers. As reporter Raj Paul discovered, cable median barrier research has helped to save lives on our highways.

- College of Engineering alumnus Dr. Kim Blair recently returned to UNL as a part of the Pierson Lecture Series. See Alif Sophian's article about Blair's presentation regarding product development.

- In March 2011, an earthquake off the coast of Japan triggered a tsunami that damaged nuclear power plants on the Japanese coast. Senior Reporter Ben Stangl breaks down the disaster and the possible engineering errors in a look at the anatomy of an engineering disaster.

Thanks to all the staff of the Nebraska Blueprint and especially to our adviser, J.S. Engebretson, for making this issue possible.

Sincerely,

Michael McEniry
Editor-In-Chief

# ENGI-BRIEFS

BY ADITYA PALNITKAR

### Department of Mechanical & Materials Engineering: A New Beginning

The fall 2011 semester marked a new beginning of sorts for the Mechanical & Materials Engineering Department. The departments of Mechanical Engineering and Engineering Mechanics merged as a result of the similarities between the programs, in addition to improving the faculty's competitiveness in the Big Ten conference. The merger opened new doors for students to begin programs such as a master's degree in materials and specialize in fields like biomedical, materials and manufacturing, among others. The department will also offer new courses for undergraduate students in the branches of engineering mechanics and materials and provide undergraduates with improved research opportunities. The Mechanical & Materials Engineering Department is working to increase the number of graduate students from 110 to 175 and the number of faculty members from 29 to 32 in the next few years.

### Burns & McDonnell Study Center

A new study center was recently added to the Engineering Library in Nebraska Hall. At 750 square feet, the Burns & McDonnell Study Center is a glass-enclosed commons area that includes a 42-inch computer monitor. This monitor and its special connection capabilities allow students to connect their laptop computers to the display, making group project work easier. Burns & McDonnell, an international engineering firm, sponsored the new study center. On Nov. 4, 2011 a group of employees from the company, including some UNL engineering alumni, visited the new center to celebrate its opening.

### eSAB (Engineering Student Advisory Board)

The college offers student councils for its programs in both Lincoln and Omaha to give students the opportunity for input into programs and to encourage more extracurricular activities. These Engineering Student Advisory Boards (eSAB) include students from every academic department and from student organizations.

<u>LINCOLN:</u> eSAB is in the planning stages for the yearly E-Week events in April, where seniors display design projects and current students participate in the week's many activities. This semester, eSAB is seeking more information regarding how the college takes into consideration course evaluations. eSAB is also contributing in the efforts to revamp the Engineering Library (Nebraska Hall) and make it a more effective use of space.

<u>OMAHA:</u> eSAB is preparing activities for engineering students in conjunction with The Peter Kiewit Institute's (PKI) annual IST&E Week in February, aligning with National Engineers Week. The council is also working with PKI administrators as they consider renovations to the building to more effectively utilize space for the colleges. They are also discussing participating in some service projects in the Omaha area.

### AICHE

The American Institute of Chemical Engineers is a student organization in Lincoln that helps students become more involved in chemical engineering-related activities. AICHE has a general meeting once each month covering such topics as resume building and finding internships. The organization provides students an opportunity to interact with people from industry; they have hosted guest speakers from EXXON Mobil, ADM and Kellogg. Students can take part in design building competitions such as Chem-E-Car, which functions due to chemical reactions. Volunteering activities include "Clean Water Action," which is focused on cleaning up lakes in Lincoln and visiting the Malone Center to help underprivileged children with small interactive projects. Tutoring sessions are provided on Tuesdays, Wednesdays and Thursdays from 7-10 p.m, focusing on freshmen and sophomore chemical engineering students.

# Dean Wei and the Future of Nebraska Engineering

BY MATTHEW NIENABER

Dr. Timothy Wei joined the College of Engineering as Dean in July 2011, following the departure of Dr. David Allen on June 30, 2010. At the same time, the university joined a new conference, with engineering colleges among the best in the nation. UNL's College of Engineering has considered itself reasonably successful (ranked 95th according to U.S. News 2012), but is it now necessary to strive for a higher level of excellence set by these new peer institutions?

Dean Wei has been working in a university environment throughout his professional career. According to Wei, "the university is a place where you can pursue research ideas to develop the fundamental science base." He says that in the 21st century, we have come to the understanding that universities must be a vital part of society. Additionally, engineering colleges must be an active participant in the real world through development of new devices and methods. For Wei, this has led to work with the paper industry, the Navy, biomedical device companies and others who have sought his expertise in the area of fluid dynamics.

With the change in conference affiliation, Nebraska Engineering has been spurred on to make changes. Unlike other conferences, the Big Ten is as much a research conference as an athletic conference. Big Ten universities are well-respected for their engineering research and education. Wei represents Nebraska at meetings of the Big Ten engineering deans and other leading universities such as Stanford, MIT, Georgia Tech and Berkeley, all of which are considered top 20 engineering schools.

**Timothy Wei, Dean,**
**UNL College of Engineering**
***Photo Courtesy: UNL Photography***

Achieving an increase in the level of knowledge and respect for the college will take time to develop. This is possible with a drive to grow, as well as the encouragement of peers and other Big Ten institutions to model after. The change in conference, however, has not led to an end in the collaboration between UNL and the universities of the Big 12 conference.

Wei sees many positive aspects currently in the UNL College of Engineering. Undergraduate education in particular is a strong point. The current student-to-teacher ratio (17:1) and the variety of educational programs, especially biosystems and the less common agricultural engineering and


**Above: Donald F. Othmer Hall, part of the engineering complex on the Lincoln City Campus.**
***Photo By: Shaoshuai Gong***

**Above: Dean Wei speaks to students at the September eSAB meeting.**
***Photo By: Amanda Kelebit***

architectural engineering, make the college very competitive. Few other universities, especially the land grants, enjoy the connection to agricultural and life sciences found at Nebraska.

Wei is also impressed by the faculty who are committed to the growth of the university through research in such areas as structures, transportation, electrical, nanomaterials and nanodevices, robotics, and biosystems engineering. In addition to the campuses in Lincoln, his oversight extends to the engineering programs in Omaha. With the aid of Kiewit, HDR, Olsson Associates and others, there exists a strong bond with the construction industry.

What Wei sees as a great challenge to all universities is how to combine the many disciplines of engineering and sciences and their varied problem-solving techniques. This is the "great challenge of 21st century colleges," he said: the need to solve large-scale, complicated problems. This is an area few engineering colleges have mastered.

In his previous positions, Wei has overseen the formation of multidisciplinary research teams on wide-ranging topics such as advanced materials manufacturing research, clean-burning coal, and arterial disease. A recent development in intra-university cooperation is the opening of Jorgensen Hall in Lincoln with the nanoscience metrology facility. This is an interface point where growth may occur between engineering and the sciences. Many faculty have already been working with the center's director, as well as the dean of the College of Arts and Sciences.

This combination of multiple disciplines has also led to the development of an MRI suite to be located in East Memorial Stadium, contributing to the college's growth in the areas of biological and biomedical engineering. Wei sees this as a time of "bringing everybody together as a community around something much bigger than the sum of the parts," with the parts including healthcare, life sciences, biological and biomedical engineering.

As for the university's future Innovation Campus in Lincoln, engineering will definitely play a part in its success. Wei has been meeting with the new director, but says it is still early concerning what engineering will do, as plans for the campus are still being developed.

According to Wei, "There is a uniform understanding across the university that engineering has to be a major partner and we are laying the groundwork for that."

UNL Chancellor Harvey Perlman is supportive of the college's plans for future growth, encouraging UNL to be "a Big Ten university in fact, not just in name." These plans will include monetary startups for projects, hiring additional faculty, and bringing in graduate students for additional research.

As such, the College of Engineering will be a major player in the university's growth initiative. The college has the capacity to add more students and additional research, solidifying Nebraska's position within the Big Ten.

# RESEARCHING SAFETY ON THE HIGHWAY

BY RAJKRISHNA PAUL

Cody S. Stolle, a graduate research assistant at UNL's Midwest Roadside Safety Facility, recently conducted research on cable median wires to reduce the number of deadly car highway accidents. He conducted this research a year ago under the direction of Dr. Dean Sicking, director of MwRSF.

Stolle explained that cable median barriers are a better alternative than traditional concrete and metal beam barriers. They are much more effective in catching vehicles on terrain where particularly steep elevation changes occur, where the surface of the road has reached a crest or trough, and in corners on high speed roadways where the potential damage from a crash is at its maximum.

Cable barriers are designed to deflect the collision force laterally, thereby reducing the impact force on vehicle occupants. It is a new technology appearing in roadside safety and will likely flourish after being installed in various states across the country. Plans for cable median barriers call for installation where there is a high potential of a crash occurring.

According to Stolle, the impact of the crash and the limit of the barriers on the ability to absorb energy depends on the angle by which a vehicle collides with the barriers. The greater the angle, the higher the impact, causing greater distortion. Barriers are designed and installed according to the best angle to provide the greatest reduction in energy.

This improved technology will be of immense help as it reduces the energy of accidents by 16-18 percent. It is estimated that this could reduce the number of fatal accidents each year by 200, and reduce the number of injuries each year by more than 1,000.

A recent study in Washington revealed some amazing safety records for cable median wire. In Washington, the annual cross-median fatal crash rate declined from 3.00 to 0.33 fatalities per 100 million miles traveled. Annual disabling accidents dropped from 3.60 to 1.76 per 100 million miles traveled. Generally, 95 percent of cars that hit cable barriers are stopped from crossing the median.

Before a cable barrier is installed, the ground is checked for hardness and strength. The harder and stronger the ground is, the higher the tension of the wires between poles. The cable median wires provide a unique combination of visual and economic appeal, in roadside and median guide application. Offering a variety of deflection options, they can be applied from heights of five feet, eight inches up to nine feet, two inches. Even the appearance of the cable wires makes it an attractive alternative to the traditional W-shape and concrete beams.

As a high tension system, the entire steel cable of the cable wire median is tensioned up to 5600 lbf (25KN). To maintain this tension, the system is attached to locking hook bolts and cable hanger straps

**Continued on page 15**

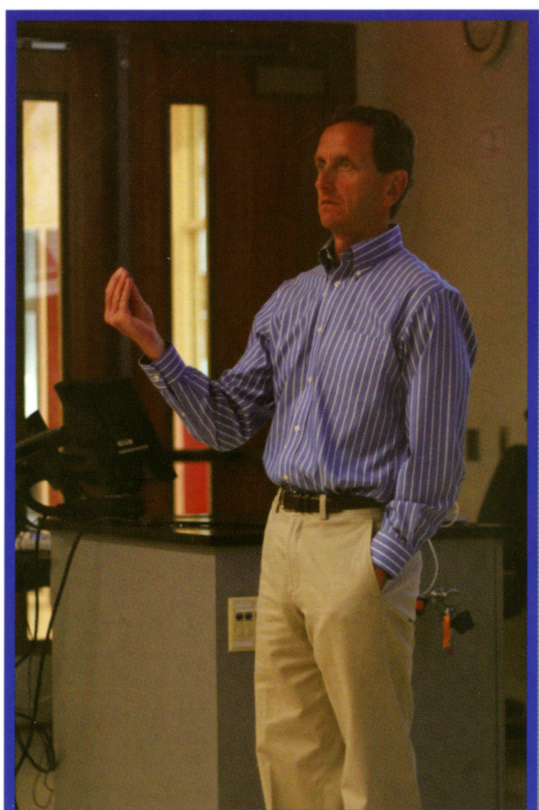
**Cable median wires along a highway.**
***Photo Courtesy: Cody Stolle***

# HUSKER ALUM RETURNS

BY ALIF SOPHIAN

Dr. Kim Blair, a Mechanical Engineering alumnus, returned to UNL Sept. 16, 2011 as part of the Pierson Lecture Series. Blair's presentation focused on "Understanding the Concept of Innovation and Technology Development," based on his broad professional experiences. He advised students to pursue interdisciplinary studies, especially the combination of business with science.

To open the presentation, Blair emphasized the high percentage of developed products that are ultimately classified as failures. Approximately 30,000 new consumer products are launched each year. Of these products, 95 percent fail to compete in national or overseas markets as noted by Professor Clayton Christensen of Harvard Business School. Eighty percent were from companies that had anticipated a superior product would attract consumers. This failure is usually attributed to financial limitations, market conditions, marketing strategy, or the company's organization.



Dr. Kim Blair during his presentation.
*Photo By: Shaoshuai Gong*

Blair then addressed what innovation really is.

"Innovation is not all about research and development. Rather, it is something that fosters improvement in terms of offerings, experiences, processes, functions and structures. An innovation is best described as the combination of insight and invention."

Blair went on to explain that while knowledge is critical to invention, people are often unable to clarify the broader meaning of insight. Insight is one of two critical elements in measuring how innovative a potential product might be. To define the interpretation of insight, he quoted famous inventor Henry Ford: 'If I'd asked my customers what they wanted, they'd have said a faster horse.'

After explaining innovation, Blair introduced the various phases of development used in preparing a product for consumers. Technology development is a critical component in all phases as it helps to minimize risk and set goals and objectives for the product.

There are five main phases used in developing the technical feasibility of a product.

---

**Phase 0:** The preliminary phase. No technical development occurs here. Instead, the basic concept or idea is developed. Questions are asked about the product's proof of technology (POT) model. All basic knowledge, necessities, mathematical calculations, technological and reasoning are applied.

---

**Phase 1:** POT is systematically transformed into a proof of concept (POC) model by visualizing the physical dimensions and appearance, collecting data from user experiences. A basic prototype is produced to focus on the possibilities and limitations of the product.

---

**Phase 2:** A combination of Phases 0 and 1, the prototype becomes an alpha prototype: the first fully integrated product assembled and approved by an engineer. Testing and data generation is performed with the alpha prototype and feedback is sought from test groups. This feedback is key to the further analysis and development of the product.

**Continued on page 15**

# ENGINEERING OFF THE ROAD

BY KATHIRGUGAN KATHIRASEN

Benjamin Franklin once said, "Energy and persistence conquer all things." Operating under this statement, UNL's Baja SAE team should be all-conquering very soon.

Despite recently returning to the intercollegiate design competition run by the Society of Automotive Engineers (SAE), the results of UNL's Baja team have been nothing short of impressive. At the Kansas race in May 2011, UNL Baja SAE placed 3rd in the suspension and traction category; 7th in tractor pull; 11th in maneuverability and 3rd overall for the first of three days of driving.


**Members of the UNL Baja SAE team.**
***Photo Courtesy: UNL Baja***

Consisting of three regional competitions, Baja SAE requires teams of engineering students to design, construct and compete with a small off-road vehicle that is both fast and durable. The competition generally spans three days with each day consisting of different evaluations.

Beginning May 26, the Kansas Baja SAE pitted the Midwestern universities against each other in a competition for regional supremacy. On the opening day, judges from Polaris Industries explained the rules, the most crucial of which were that teams were only allowed to use an unmodified Briggs & Stratton Intek 20 single-cylinder engine.

With a displacement of 300cc and power output of approximately 10 bhp (7.5 kW), the Briggs & Stratton Intek 20 is an ideal engine for Baja SAE. Aside from the engine requirement, students are permitted free range in the design of their vehicles.

Judges also explained the criteria by which the vehicles would be evaluated. Suspension, chassis, brakes, ride comfort, build cost and even the appearance were all factors in the evaluation. Individual vehicles then underwent technical inspections to verify that no rules were violated and that all parts were in good working condition. Calculations used in the construction of the vehicle were also checked to ensure no mishaps had taken place.

Then, there was an oral presentation for teams to show everyone the design and build of their vehicle and pitch their sales idea. They were also required to submit a cost report in which the feasibility of their build was evaluated based on its cost.

The individual racing events took place on the second day. Four separate racing events featured acceleration, maneuverability, tractor pull, and suspension and traction. Each of these was used to test the different capabilities of the vehicle.

Two additional events were conducted at the Illinois competition during the summer of 2011. These were hill climb and rock crawl.

Day three of the competition was a combination of events from the previous days designed to test the endurance limit of the vehicles. At the conclusion of this test, the vehicle had to survive 1.5 miles of rough terrain with obstacles in the forms of trees, rocks, steep inclines and mud. This endurance test was aimed at testing and breaking the vehicles, but the UNL Baja SAE team's vehicle was strong enough to last the day.

The UNL Baja SAE vehicle covered in mud.
*Photo Courtesy: UNL Baja*

Corey Kruse, Baja SAE team leader and president of Husker Racing, recalled an amusing story about the endurance race. For the 2010 Baja SAE event in Washington, he was the designated driver for the endurance race. During the first lap, there was a particularly sharp horseshoe-shaped curb that caught him off guard. He attempted to correct the vehicle's path, but the car rolled over on the course and triggered a massive pileup. Uninjured, he chuckled as he reminisced over the moment: "...and I was drenched in mud." The team would later rejoin the race.

Following the three-day competition in Kansas, UNL's Baja SAE team earned plaques for placing 3rd in the suspension and traction category and 3rd overall for the first day of races. As a part of their success, the team was awarded $525 prize money.

"Time constraint is the biggest issue a Baja team member has to address," said Kruse.

He said juggling being both an active Baja member and doing well in school has been a wonderful learning experience. He urges more students to join Husker Racing, as this is an excellent opportunity to grow into more well-rounded individuals.

Baja SAE teaches students to be self motivated and disciplined, and these are lifelong habits that will be useful, whether at school or in the workforce, he added.

There are few prerequisites to joining Baja except for a burning desire to build strong, durable race-worthy vehicles. The benefits, however, for the individual are plenty. Thanks to close interaction with sponsors/donors Kawasaki and TMCO, students get real-world exposure to the worlds of manufacturing and design. Students also learn how engineering theories and principles are applied. As every engineer knows, it is pivotal to have both theoretical knowledge and practical applications of that knowledge.

On top of this, students also acquire an appreciation for the immense teamwork that goes with starting and consistently being involved in something as time- and energy-consuming as building an entire competitive vehicle from scratch.

Above all else, Baja SAE teaches a student to strive to be the best he/she can be, and constant improvement is crucial.

As Josh DeBoer, vice-president of Husker Racing, said, "A great person once said, 'if you're not first, you're last.' And we don't want to be last."

It would come as no surprise if Husker Racing managed to come out on top in future Baja SAE events.

# ANATOMY OF AN ENGINEERING DISASTER

BY BEN STANGL

Catastrophe. Disaster. Tragedy. A few simple words in a headline can speak volumes to a general public finely tuned to local, national and world news. Interest is captured as questions arise: Who? What? When? How? Why? The answers to these questions, in both content and delivery, are staged in an arena where a critical evaluation of ethics is carefully hung in the balance.

Fracture. Buckling. Fatigue. Corrosion. Modes of failure invoke the same critique for an engineer as the headlines above do for the layperson. Being detail oriented, information is compiled: What failed? Why did it fail? What could have been done to prevent the failure? Who was at fault, and why? Also, what ethical issues might have been at least partly responsible for the failure and could an absence of "professionalism" or "conscientiousness" have helped lead to this failure?

A recent contemporary disaster combined human industry and the forces of nature. Fukushima, Japan is the site of six boiling water reactor nuclear power plants that make up the Fukushima Daiichi nuclear power plant, which met a fateful demise on March 11, 2011. A 9.0 magnitude earthquake off the coast in Tohoku triggered a tsunami that reached the Japanese coast in just under an hour. The power plants sustained damage during three stages of the event: earthquake, tsunami, and the loss of cooling function.

A nuclear plant generates electricity by heating water to steam that then turns the turbine of a generator. Heat is generated in the reactor core by splitting uranium atoms in a fission chain reaction. A reactor continues to generate heat even after the chain reaction is stopped as a result of the radioactive decay of unstable isotopes created during the fission process. If this heat is not monitored and controlled, it may increase to levels that pose danger to the reactor and the possible release radiation. Decay heat exists many years after nuclear fuel has been decommissioned. The decommissioned fuel, known as spent fuel, is stored in spent fuel pools. For this reason, both reactors and spent fuel pools are designed with cooling systems of circulating water.

Cooling pumps are used to circulate cooling water when the reactor is shut down and not producing electricity. These pumps can be powered by battery units located on-site, by other electrical generation units off-site through the power grid, or by diesel generators. Additionally, boiling water reactors have steam-turbine driven emergency core cooling systems that can be directly operated by steam still being produced after a reactor shutdown. This system can inject water directly into the reactor as long as the reactor is producing steam and there is enough water that has not boiled. In all cases, some electrical power is needed to operate the valves and monitoring systems.

Even with the numerous emergency cooling systems, plants are constructed to prevent radiation leaks in an emergency through the use of a protective containment structure built with tons of concrete and steel.

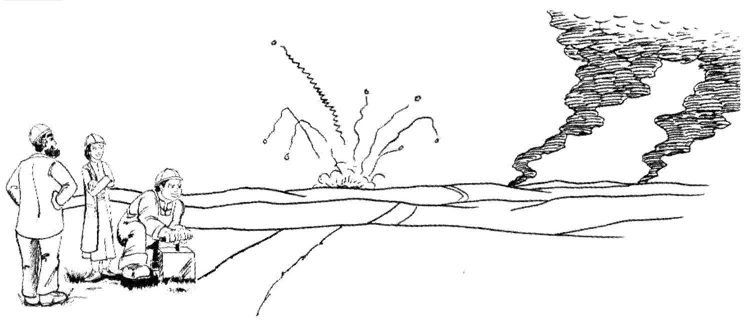
At the time of the earthquake off the Japanese coast, reactor unit IV had been de-fueled while units V and VI were in cold shutdown for planned maintenance. The remaining reactors shut down automatically as a result of the earthquake, with emergency generators starting up to run electronic control systems and water pumps needed to cool the reactors.

Less than an hour later, the entire site was flooded by a tsunami wave upwards of 15 meters in height. Low-lying generators and electrical switchgear rooms in reactor basements were knocked out. External pumps for supplying cooling seawater were left without power. Even the fuel tanks for the diesel generators were swept away, and connections to the electrical grid were severed as the tsunami destroyed power lines. With all power for cooling lost, the reactors started to overheat from the natural decay heat combined with the residual heat that remained prior to shutdown.

The intense, growing heat caused full meltdowns in reactor units I, II and III. As the meltdown proceeded, portions of the core melted and slumped into the remaining water in the bottom portion of the reactor pressure vessel, where it momentarily cooled before reheating. During meltdown, the cores of the three units were vented as pressure within the containment structure increased to dangerous levels. The effects of the venting caused hydrogen explosions that destroyed the upper cladding of the buildings housing reactors I, III, and IV, and multiple fires broke out at reactor unit IV.

Reactor cores were not the only sources of dangerous decay heat; spent fuel was also in a compromised state with both the circulating cooling water systems out of commission and cracks in the pools allowing water leakage.

Fears of radioactivity releases led to a wide residential evacuation around the plant, while workers suffered radiation exposure and were temporarily evacuated at various times. Six days following the start of the incident, a generator was restarted to provide some cooling at reactors V and VI, which were the least damaged of the six units. Electric power from the grid was restored to parts of the plant after three more days, but reactors I through IV were still inaccessible and the cooling systems inoperable. Flooded water from the tsunami served as a medium to further spread radiation and contamination. Finally, on May 5, 2011, workers entered reactor buildings for the first time following the accident to perform repairs.



**Graphic reproduced from October 1984 Blueprint by artist Stephan Campbell Hill.**

With a brief explanation of what happened and why, now engineers and lay people alike ask the question, "Could this have been prevented?" and "Who is responsible for the event?" The nuclear energy industry employs multiple systems for emergency cooling, yet all were inoperable in the case of the Fukushima disaster. Constructed in an earthquake-prone location, the plants were designed for seismic events. However, it is understandable that a seismic design has limits and a magnitude 9.0 event was not factored into the design basis. The natural forces of nature are far less predictable than those within a system designed and maintained by humans, but surely other measures could have been taken to prevent this disaster.

The second plant, Fukushima Daini, which was also struck by the tsunami, incorporated design changes that improved its resistance to flooding and as a result sustained less damage than Fukushima Daiichi. Generators were located in the watertight reactor building rather than the turbine building that sustained heavy flooding. Seawater pumps for cooling were given protection from flooding, and although three of four failed in the tsunami, they were restored to operation.

Was the original Fukushima plant modified to reflect the preventative measures incorporated in the second plant? To comply with new regulatory requirements established in the late 1990s, three additional backup generators for reactors II and IV were placed in new buildings located at higher elevations and further from the coast. All six reactors were given access to these generators; however, the switching stations that sent power from these backup generators to the reactors' cooling systems for reactors I through V were still in the poorly protected turbine buildings. All three of the generators added in the late 1990s were operational after the tsunami. Had switching stations been moved inside the reactor buildings or to other flood-proof locations, power would have been provided by these generators to the reactors' cooling systems.

This is just one example of how disaster could have been averted.

**Continued on page 14**

# ANATOMY OF AN ENGINEERING DISASTER

continued from page 13

Spent fuel pools are another issue needing be addressed. The damage sustained by the pools, which were elevated in the containment structure, was a result of the earthquake. Storage of spent fuel is a controversial subject for the nuclear industry, governments, and general public. Clearly however, the concentration of spent fuel stored in such a vulnerable position and location was a negligent act. Off-site, dry-cask storage is a much more conservative and prudent alternative.

The safety history of the Fukushima nuclear power plant was subject to a falsified-records scandal that resulted in the firing of a number of senior executives of Tokyo Electric Power Company (TEPCO). Previously unreported problems at the plant were then disclosed. Reactor design plans provided by General Electric specified placing generators and batteries in the basements of the uncontained reactor turbine buildings, but engineers were appropriately concerned that this made the back-up power systems vulnerable to flooding. However, TEPCO chose to follow General Electric's design. Other problems included a power board distributing electricity to a reactor's temperature control valves that was not examined for 11 years. Inspections frequently did not include devices related to cooling systems.

In addition to the concerns within Japan, the International Atomic Energy Agency (IAEA) was also concerned about the ability of Japan's nuclear plants to withstand seismic activity. An IAEA expert warned that a strong earthquake with a magnitude in excess of 7.0 could pose serious problems for Japan's nuclear power stations.

The Japanese government released a TEPCO report to Japan's Nuclear and Industrial Safety Agency (NISA). Contained in this report were papers that proved TEPCO was aware that the plant could be hit by a tsunami with waves twice as high as the 5.7 meter design basis.

This indicates a level of conscientiousness that TEPCO chose to ignore, violating the NSPE code of ethics canon to "hold paramount the safety, health, and welfare of the public."

In answering the questions that arise from an engineering disaster, the expectation is for an immediate solution but also experience to prevent disasters in the future by correcting past inadequacies and use a broadened understanding to make more effective predictions. In this way, engineers may conduct themselves honorably, responsibly, ethically, and lawfully to enhance the honor, reputation, and usefulness of the profession.

## Fundamental Canons

*Engineers, in the fulfillment of their professional duties, shall:*

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

**Sources: Anatomy of an Engineering Disaster**

Yoshida, Reiji, "GE plan followed with inflexibility", *Japan Times*, 14 July 2011, p. 1.

Norihiko Shirouzu and Rebecca Smith (16 March 2011). "Plant's design, safety record are under scrutiny". *The Wall Street Journal*. http://online.wsj.com/article/SB10001424052748704396504576204461929992144.html.

"Operator of Fukushima nuke plant admitted to faking repair records". *Herald Sun*. Australia. 20 March 2011. http://www.heraldsun.com.au/news/special-reports/operator-of-fukushima-nuke-plant-admitted-to-faking-repair-records/story-fn858jk3-1226024977934. Retrieved 24 April 2011.

"IAEA warned Japan over nuclear quake risk: WikiLeaks". *Daily Telegraph*. physorg.com. 17 March 2011. http://www.physorg.com/news/2011-03-iaea-japan-nuclear-quake-wikileaks.html.

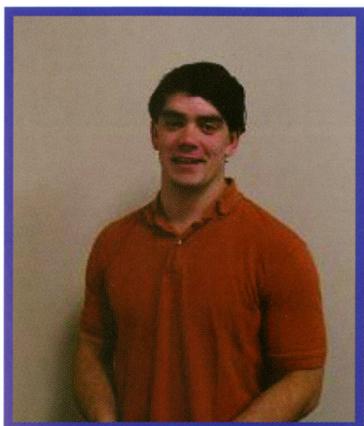
"NSPE Code of Ethics for Engineers" 10 October 2011 http://www.nspe.org/Ethics/CodeofEthics/index.html

## RESEARCHING SAFETY ON THE HIGHWAY

continued from page 8

that absorb energy during crashes. It is anchored at both ends into FHWA-accepted Cable Release & Trigger Posts. Cables are tightened and stretched by turnbuckles. Installers can then customize tensions to meet site needs. Most of the cables use TL-3(3 cable) and TL-4 (4 cable) systems.

Development of cable median wires started in the late 1960s. Initial advances were developed by the New York State Department of Transportation. They developed a 3-strand cable barrier system mounted on a weak steel post. At the time, the system was designed strictly for testing and was not thought to be something used on highways. Today, cable median wires have flourished as a new highway safety system, replacing the old concrete highway barriers at an ever-increasing rate.



**Cody S. Stolle**
***Courtesy Photo***

In 2010, the state of Washington rolled out the installation of cable median wires statewide to prevent cars from crossing medians and causing head-on collisions.

Before installing cable barriers, engineers consider whether barriers will enhance safety and if so, which type of barrier would work best for each location. The array of factors considered are accident trends and history, community and driver comments, traffic speed and volume, road grade, angle and curve, available median and shoulder space, slope of the median, barrier characteristics, installation and maintenance cost.

Back in Washington State, the department of transportation replaced sections of low tension cable barriers with high tension cable barriers. This was a result of repeated failures of lower tension cables in accident situations. The Washington State DOT also has used American Recovery and Reinvestment Act funds to install cable wire medians along Interstate 5 from Marysville to the Stillaguamish River. This cost an initial $2.5 million with an additional $9 million for reconstructing the cable barriers.

Cable wire medians are a beacon of hope for improving the odds of surviving an accident. Even as research continues into improved designs, it is still important for motorists to take personal safety precautions. This includes always wearing a seat belt, no matter how short or long the trip.

UNL will continue to be at the forefront of this research through the research of graduate students like Stolle.

## HUSKER ALUM RETURNS

continued from page 9

**Phase 3:** With the technology concepts approved, questions are no longer asked about the design. The prototype is fully integrated and the final design is completed with material selection, manufacturing methods outlined and preparation for mass production.

**Phase 4:** The final stage for the development. The product is ready for the production line and will later be released into the market.

In a nutshell, innovation is about asking good questions based on insight and innovation in regard to our idea.

A native of Nebraska, the University of Nebraska-Lincoln awarded Blair the prestigious Alumni Achievement Award in 2005. As a student, he earned a B.A. in Psychology and a B.Sc. in Mechanical Engineering. He earned an M.S. in Mechanical Engineering and a Ph.D. in Aeronautics and Astronautics at Purdue University.

An ironman triathlete, Blair is vice president of Cooper Perkins, a technology development and product engineering consulting firm specializing in highly integrated electromechanical systems.

UNIVERSITY OF Nebraska Lincoln



## Want to get involved in the Blueprint?

For more information about the Blueprint and how to join the staff, contact unlblueprint@gmail.com.